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TOOL STEELS

CARNEGIE STEEL COMPANY
PITTSBURGH, PA.

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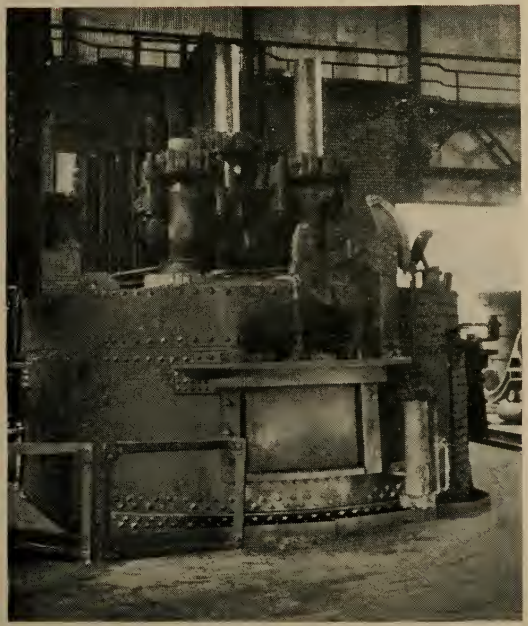

General View

Pouring a Heat

ELECTRIC FURNACE AT DUQUESNE STEEL WORKS, CARNEGIE STEEL COMPANY

TOOL STEELS

DATA AND TABLES
APPERTAINING
TO
ELECTRIC
TOOL STEELS

MANUFACTURED BY
CARNEGIE STEEL COMPANY
PITTSBURGH, PA.

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Steel is a complex mixture of iron with other ingredients. Some of these ingredients are impurities, the kinds and amounts of which depend on process of manufacture and raw materials used. Other ingredients impart useful properties to metal and are added to or allowed to remain in the steel to produce or intensify these properties.

The aim of the steel maker is to reduce the proportion of impurities to the minimum and to add to the iron just that percentage of useful ingredients which will give those chemical and physical properties most suitable for the uses to which the particular grade of steel is to be put.

CLASSIFICATION OF STEEL. Various grades of steel are classified by uses, processes of manufacture or chemical composition.

1. Uses. Structural Steel is that grade in general use in the fabrication of bridges, buildings, cars and ships. Spring Steel goes into the manufacture of car and carriage springs, etc. Tool Steel is peculiarly adapted to be hardened and tempered for the manufacture of machine and hand tools of all kinds, etc.

2. Processes of Manufacture. The terms, Crucible Steel, Bessemer Steel, Acid Open-Hearth Steel, Basic Open-Hearth Steel and Electric Steel, refer to different methods of manufacture and are somewhat indicative of quality for the reason that a particular grade of steel is best made by one or the other of these processes.

3. Chemical Composition. On the basis of chemical composition there are three main kinds of steel.

a. Carbon Steel. In addition to phosphorus and sulphur which are present only in such small quantities as it is impossible to remove in the process of manufacture, carbon or plain steels contain iron, carbon

and manganese, though the percentage of carbon and manganese may be very small. Differences in these steels as to hardness, tensile strength, temperability, etc., are due in the main to the different percentages of carbon which they contain.

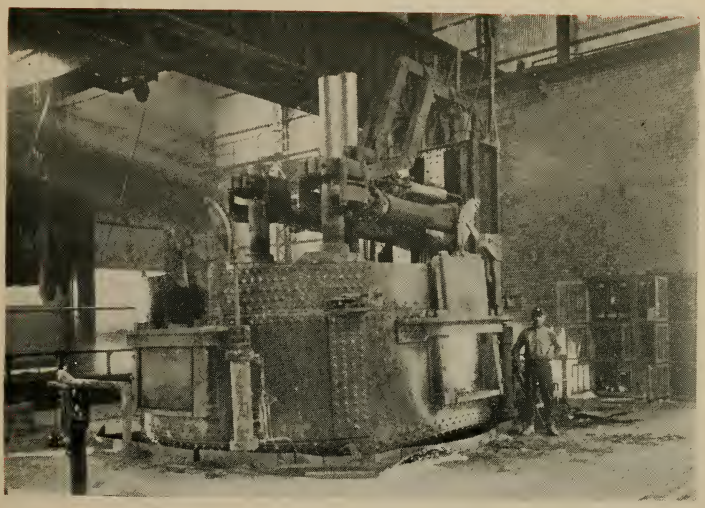
b. Alloy Steel. In addition to iron, carbon and manganese, alloy steels contain some element or elements which may have been added or allowed to remain, to modify and improve mechanical properties so as to make them more suitable for particular uses. These are often named from the element or elements which impart the distinctive properties; nickel steel, chrome-nickel steel and tungsten steel are examples.

c. Alloy-Treated Steels. Alloy-treated steel is carbon steel with the addition of an alloy in small quantities for curative purposes. While the percentage of alloy is not sufficient to impart markedly distinctive properties, its addition serves to improve the natural properties of the carbon steel. Such steels are not properly classed as alloy steels.

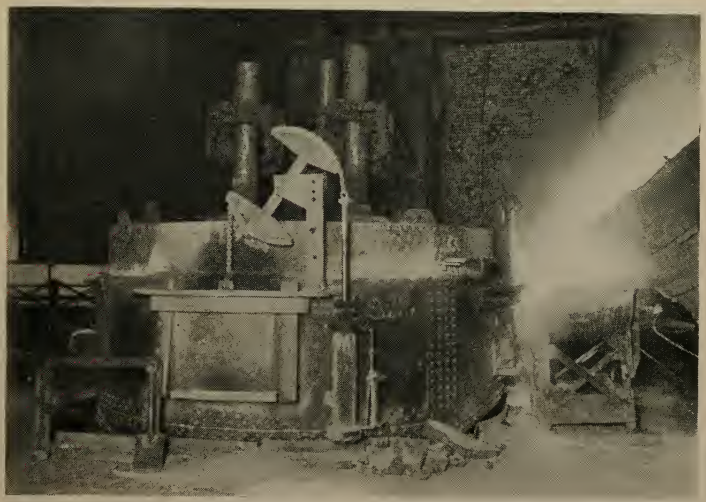
FACTORS AFFECTING QUALITIES OF STEEL. Chemical composition, method of manufacture, mechanical treatment in shaping and heat treatment before use, are all factors of importance in developing maximum serviceability in steel. Service failures may be due either to improper manufacture or to improper treatment after manufacture.

Since the chemical composition, the method of manufacture and much of the mechanical treatment are factors that rest with the steel maker, it is obvious that to produce the best steel for any particular use requires adequate and proper facilities and skill in manufacture.

On the basis of experience Carnegie Steel Company recommends for tools its carbon steels made in the electric furnace with those percentages of carbon indicated by experience as best suited for the particular use to which such tools are to be put, in the confidence that, when the steel has been properly made and properly treated, carbon steel may be made to serve the requirements of the tool maker for most purposes as well as the more expensive alloy steels. Service failures will likely be due to use of the improper grade or to defects in heat treatment.



Ready to Charge Hot Metal



Charging Hot Metal from Open-Hearth Furnace

FIG. 1. ELECTRIC FURNACE—DUQUESNE STEEL WORKS

At Commencement of Heat

Ready to Cast Steel into Ladles

FIG. 2. ELECTRIC FURNACE—DUQUESNE STEEL WORKS

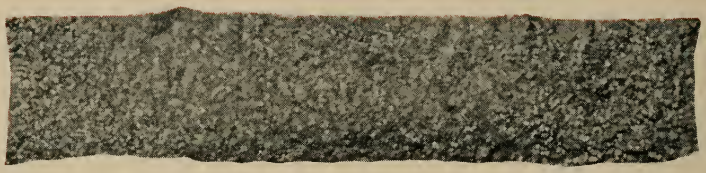
HEAT TREATMENT. Dependent upon the arrangement of the particles of carbon and iron, steels of the same chemical composition may be soft or hard. The purpose of heat treatment is to further refine the grain structure of well-made steel and to retain a desired arrangement of the particles of carbon and iron. By proper heat treatment it is possible with steels of the same chemical composition to obtain the structures characteristic of hardened steels or that of annealed steel, structures in which a given steel is in its hardest condition or where maximum ductility is combined with the greatest strength or, again, where it is the softest.

Metcalf test pieces, Fig. 3, show clearly the effect of temperature on grain size. A piece of tool steel of convenient size is lightly nicked across, hot, at intervals of about one inch or an inch and a half. One end is then placed in a fire and gradually heated until it is actually burnt or melted as shown by the shower of sparks when it is taken out. The heat travels back from the heated end so that the temperature varies along the bar from a melting heat, where it was in the fire, to a black heat or almost cold at the other end. As soon as the bar has been heated, it is quenched in water (to make it easier to break), dried carefully (so no water will reach the fractures and rust them) and broken at the nicks.

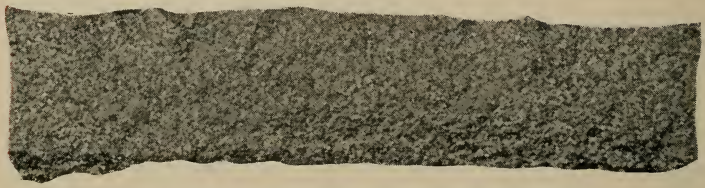
Based on the appearance of the fractures, the bar may be divided into three portions:

1. Where the grains are unchanged, having the same size as in the bar before it was heated. This is the portion of the bar away from the fire where the temperature has been below the hardening point.

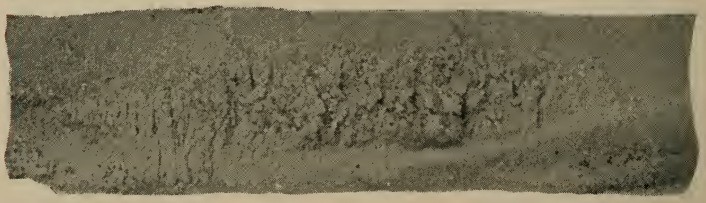
2. Where the grains are extremely fine and dull with the appearance of broken porcelain. This is the portion of the bar heated only just above the hardening temperature, and the fine grain size shows the refinement due to quenching at the proper temperature.



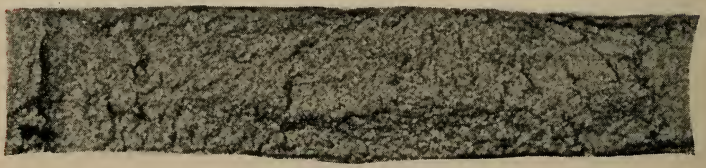
5. Greatly Overheated and Quenched



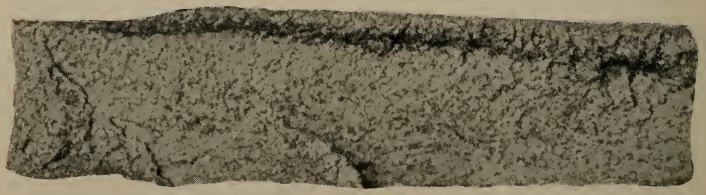
4. Heated just above Hardening Point and Quenched



3. Heated to Hardening Point and Quenched



2. Annealed and Quenched



1. Normal Steel as Rolled

FIG. 3.—METCALF TEST PIECES
Carnegie Electric Tool Steel No. 1

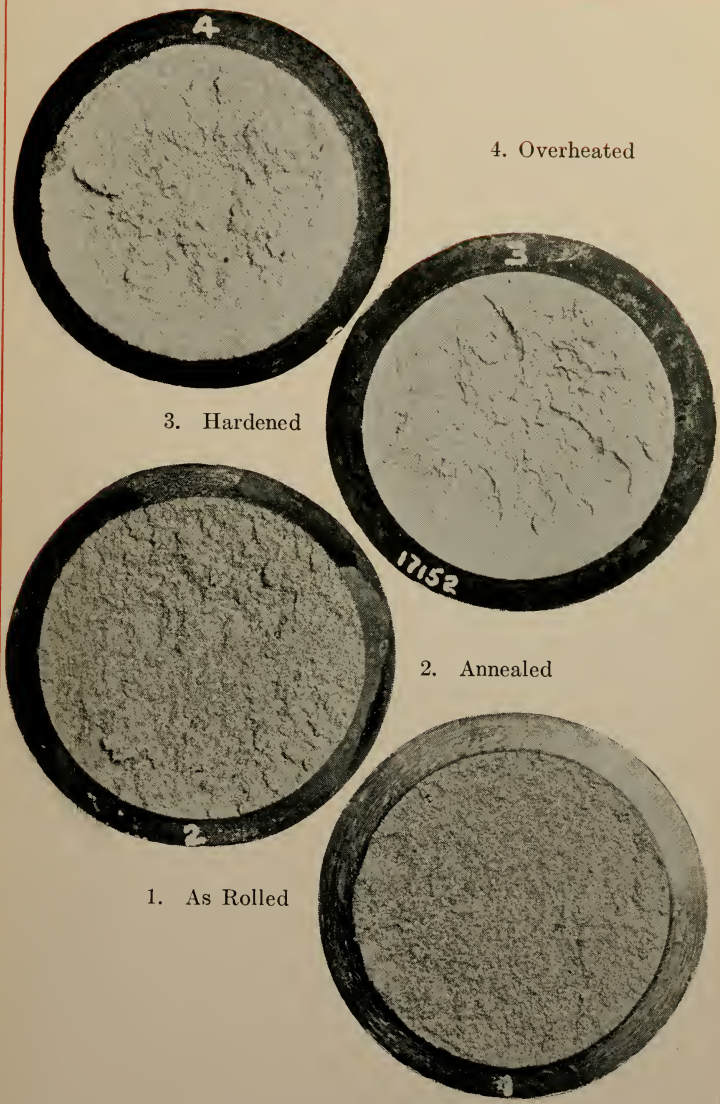


FIG. 4. FULL SIZE TEST PIECE FRACTURES
Carnegie Electric Tool Steel No. 1

3. Where the grains are very coarse and bright. These are progressively larger towards the melted end of the bar and show the growth in grain size which takes place when steels are heated above the hardening point.

Maximum hardness occurs with minimum grain size. To insure this condition steels must be heated above the hardening point. The temperature should be held just above this point to insure uniform heating throughout the bar, but beyond this point steel should not be heated more than absolutely necessary.

HARDENING POINT. The hardening temperature for tool steels (the point of minimum grain size) varies with the chemical composition. In carbonless iron it occurs at about 1697° F.; in steels of .90 carbon or over, at 1382° F. It is also affected by the presence of alloys.

The line of minimum grain size for carbon steels of different composition is shown on the chart, Fig. 6. Companion, Fig. 5, shows the heat colors which are indicative of the different temperatures reached by continuous application of heat. The estimation of temperature by color is liable to the objection that difference in color distinction is bound to exist among different operators and that distinction of color is also affected by different light conditions. More constant results are obtained by the use of pyrometers which should be frequently standardized.

METHODS OF HEAT TREATMENT. While explicit directions for working each grade of Carnegie Electric Tool Steel will be given later, some general remarks in regard to the three processes of annealing, hardening and tempering may be of value.

1. Heating. The heating of steel is either for the purpose of forging or otherwise working, or else as a special treatment for annealing, hardening or tempering. In

heating for forging, the piece is heated uniformly throughout to the temperature desired but is not held in the fire after right heat is reached. The piece is then forged rapidly with as few reheats as possible. Too high a temperature should be avoided, as otherwise the steel may be burnt or become coarse-grained and brittle. The higher the carbon, the lower must be the heat.

2. Annealing. After forging, it is usually advisable to anneal, to relieve any strains which may have arisen and also to make the steel as soft as possible in cases where machining operations are necessary for the proper shaping of tools such as milling cutters. Annealing consists in reheating the steel (after it has become cold) to a temperature slightly above the hardening point but not so high as is permissible for forging. When the steel shows uniform heat, it is allowed to cool slowly in the furnace or in lime or ashes until it is black. This slow cooling may be continued until the piece is quite cold or it may be cooled the rest of the way in water, for it is now cooled below the hardening point and will not be affected by quenching.

3. Hardening. When tool steel is to be hardened, it is reheated evenly on a rising temperature to just above the hardening point or, if grade is not known, to the lowest heat at which the steel will properly harden, quenched in water or oil dependent on carbon content, section and degree of hardness required. Steel will not be hardened if heated below the hardening point even though quenched in water. Heating beyond the lowest required temperature will not increase the hardness but makes the grain coarse and increases the brittleness. If steel is overheated, cool to a black color and reheat before hardening.

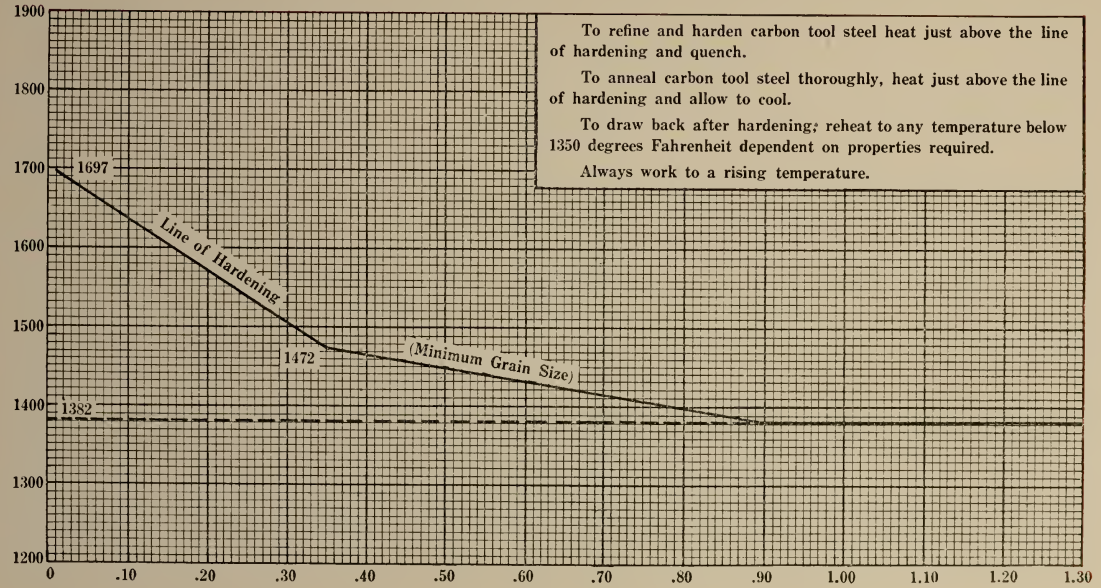
4. Tempering. Tempering or drawing consists in reheating hardened steel to a low temperature for the purpose of removing the excessive brittleness which it has

TABLE I.—HEAT COLORS

Temperature		Color	Name of Color
Centigrade	Fahrenheit		
1204	2200		White.
1079	1975		Light Yellow.
996	1825		Lemon.
941	1725		Orange.
899	1650		Salmon.
843	1550		Bright Red.
746	1375		Light Cherry Red.
677	1250		Medium Cherry.
635	1175		Dark Cherry.
566	1050		Blood Red.
482	900		Dark Red.

TABLE II. HEAT TREATING TEMPERATURES FOR CARBON STEELS

Degrees Fahrenheit Corresponding to Various Percentages of Carbon



To refine and harden carbon tool steel heat just above the line of hardening and quench.

To anneal carbon tool steel thoroughly, heat just above the line of hardening and allow to cool.

To draw back after hardening; reheat to any temperature below 1350 degrees Fahrenheit dependent on properties required.

Always work to a rising temperature.

received from quenching but without affecting the hardness more than can be avoided, the result sought being a steel which is both hard and tough. After heating for tempering, the cooling may be done in water or by holding the tool in a heated sand or salt bath or in an oil or lead bath controlled by a reliable pyrometer. The proper temperature for tempering may be determined by observing the oxide color that forms on a fresh surface when the tempering is done in a furnace. Standard temper colors with the corresponding names and degrees Fahrenheit and Centigrade are shown on Table III.

Approximate temperatures and colors for tempering different classes of articles are as follows:

Medium Yellow..450° F.—Drills, Mill Picks, Taps, Reamers, Shear Blades, Screw Dies, Punches.

Brown Yellow ...500° F.—Cold Chisels, both Hand and Pneumatic, Hot Sets, Shear Blades of medium size, Large Punches, Miners' Drills for Granite, Beading Tools, Calking Tools.

Dark Purple.....550° F.—Smith's Tools, Set Hammers, Swages, Flatteners, Fillers, Hot and Cold Cutters.

Peacock Blue....600° F.—Boiler Snaps or Sets, Hammers, Stamping or Pressing Dies.

TABLE III.—TEMPER COLORS

Temperature		Color	Name of Oxide Color
Centigrade	Fahrenheit		
343	650		Gray Green.
316	600		Peacock Blue.
288	550		Dark Purple.
260	500		Brown Yellow.
232	450		Medium Yellow.
Atmospheric			Normal Steel.

CARNEGIE TOOL STEEL No. 1

Carbon 0.70 to 0.80

Treatment: Anneal at light cherry red, 1450° F.
Forge at bright red, 1600° F.
Harden and quench at light cherry red, 1450° to 1500° F.
Draw to suit character of work.

Uses: A General-Purpose Tool Steel.

DIES:

Drop Hammer Dies.
Shoe Dies.

FABRICATING SHOP TOOLS:

Bull Sets (Hot Work).
Eye Pins.
Pneumatic Hammer Tools (Hot Work).
Hot Punch Bars.
Hot Rivet Sets.
Sledges.
Wrenches.

GENERAL PURPOSES:

Bucket Teeth.
Cold Chisels (Small).
Mattocks.
Picks.
Wedges.

LOGGING TOOLS:

Becket Hooks.
Butt Hooks.
Cant Hooks.
Choker Hooks.
Dog Hooks.
Mauls.
Wedges.

MACHINE SHOP TOOLS:

Shear Blades (Soft Work).
Table Blades (Soft Work).
Wrenches.

MINE AND QUARRY TOOLS:

Mine Drills.
Rock Drills (Soft Work).

SMITH'S TOOLS:

Anvil Facing.
Cold Chisels.
Flatters.
Fullers.
Hammers.
Tongs.
Vises.

STONE CUTTER'S TOOLS:

Crow Bars.
Pinch Bars.

TRACK TOOLS:

Picks.
Pick Points.
Pinch Bars.
Sledges.
Spiking Hammers.
Track Punches.
Track Sets.

CARNEGIE TOOL STEEL No. 2

Carbon 0.80 to 0.90

Treatment: Anneal at light cherry red, 1400° F.
Forge at bright red, 1600° F.
Harden and quench at light cherry red, 1400° to 1450° F.
Draw to suit character of work.

Uses: A General-Purpose Steel for Soft Work.

DIES:

Bolt Machine Dies.
Bottom Blanking Dies.
Cold Heading Dies.
Forging Dies (Soft Work).
Glove Dies.
Rivet Machine Dies.

FABRICATING SHOP TOOLS:

Calking Tools.
Chipping Chisels.
Cold Nut Punches.
Drift Pins.
Hot Punches.
Hot Rivet Sets.
Pneumatic Hammer Cylinders.
Washer Punches.

GENERAL PURPOSES:

Hoes.
Ice Plows.
Road Scraper Plows.
Skate Blade Punches.
Scissors.
Shears.

LOGGING TOOLS:

Cant Hooks.
Grabs.
Sledges.

MACHINE SHOP TOOLS:

Ball Peen Hammers.
Chuck Jaws.
Cold Chisels.
Jig Steel.

MINE AND QUARRY TOOLS:

Clay Chisels.
Drills.
Quarry Drills.
Star Drills.

SMITH'S TOOLS:

Cold Cutters (Hand).
Flatters.
Hand Chisels.
Hot Chisels.
Saw Swages.
Tongs.
Vise Jaws.

STONE CUTTER'S TOOLS:

Four-Point Tools.

TRACK TOOLS:

Digging Bars.

CARNEGIE TOOL STEEL No. 3

Carbon 0.90 to 1.00

CARNEGIE STEEL CO. | No. 3 | ELECTRIC TOOL STEEL

Treatment: Anneal at light cherry red, 1400° F.
Forge at bright red, 1550°F.
Harden and quench at light cherry red, 1400° to 1450° F.
Draw to suit character of work.

Uses: A General-Purpose Steel for All Uses.

AGRICULTURAL IMPLEMENTS:
- Lawn Mowers.
- Pitch Forks.
- Pruning Shears.

BOILER SHOP TOOLS:
- Beading Tools.
- Cones.
- Flue Rollers.

DIES:
- Blanking Dies.
- Cold Heading Dies.
- Hot Hand-Feed Dies.
- Rivet Heading Dies.
- Stamping Dies.

FABRICATING SHOP TOOLS:
- Cold Punches.
- Cold Rivet Dies.
- Cold Rivet Sets.
- Cold Rivet Snaps.
- Pneumatic Hammers(ColdWork).
- Sledges.

GENERAL PURPOSES:
- Dredge Bucket Teeth.
- Hammers.
- Magnets (Permanent).
- Nail Pullers.
- Pliers.
- Putty Knives.
- Pocket Knife Blades.
- Set Screws.
- Spring Steel.
- Steam Shovel Bucket Teeth.

LOGGING TOOLS:
- Cant Dogs.
- Peavies.

MACHINE SHOP TOOLS:
- Hot Straighteners.
- Lathe Centers.
- Reamers.
- Taps.
- Threading Chasers.

MINE AND QUARRY TOOLS:
- Augers.
- Drills.
- Plug Drills.
- Pick Points.
- Stamps.

SMITH'S TOOLS:
- Anvil Cutters.
- Cold Cutters.
- Formers.
- Hammers.
- Sledges.
- Swages.
- Tongs.

STONE CUTTER'S TOOLS:
- Planer Tools.
- Pinch Bars.
- Wedges.

CARNEGIE TOOL STEEL No. 4

Carbon 1.00 to 1.15

Treatment: Anneal at light cherry red, 1400° F.
Forge at bright red, 1500° F.
Harden and quench at light cherry red, 1400° to 1450° F.
Draw to suit character of work.

Uses: A Steel for General Machine Shop Tools.

AGRICULTURAL IMPLEMENTS:

Hay Rakes.
Machine Knives.
Scythe Edges.

BOILER SHOP TOOLS:

Calking Tools.
Cones.
Expander Rolls.
Flue Expanders.
Mandrels.
Pipe Cutters.

DIES:

Cold-Punching Horse Shoe Dies.
Die Plates.
Drawing Dies.
Embossing Dies.
Forging Dies (Hard Work).
Forming Dies.
Nail Dies.
Pipe Dies.
Screw-Cutting Dies.
Threading Dies.
Trimming Dies.
Trip Hammer Dies.

GENERAL PURPOSES:

Carver Knives.
Hatchets.
Knife Blades.
Paper Knives.
Skates.

LOGGING TOOLS:

Axes.
Bevel Axes.
Bit Axes.
Broad Axes.
Splitting Axes.
Tie Axes.

MACHINE SHOP TOOLS:

Arbors.
Flat Drills.
Lathe Centers.
Lathe Tools (Soft Metal).
Mandrels.
Milling Cutters.
Planer Tools (Soft Metal).
Rotary Shears.
Shear Blades.
Shear Knives.

MINE AND QUARRY TOOLS:

Channeling Machine Bits.
Paving Drills.

STONE CUTTER'S TOOLS:

Bush Hammers.
Chisels (Soft Rock).

CARNEGIE TOOL STEEL No. 5

Carbon 1.15 to 1.30

Treatment: Anneal at light cherry red, 1400° F.
Forge at bright red, 1500° F.
Harden and quench at light cherry red, 1400° to 1450° F.
Draw to suit character of work.

Uses: A Steel for General Small Machine Shop Tools.

BOILER SHOP TOOLS:

- Flue Cutters.
- Tube Scrapers.

DIES:

- Cartridge Shell Dies.
- Jeweler's Dies.
- Printing Machine Dies.
- Stamp Dies.
- Tong Dies.
- Wire Drawing Dies.

GENERAL PURPOSES:

- Cant Saw Files.
- Glass Cutters.
- Mill Picks.

MACHINE SHOP TOOLS:

- Cabinet Files.
- Cross Cut Files.
- Drills.
- Metal Turning Tools (Soft Metal).
- Pillow Files.
- Roll Turning Steel.
- Slim Taper Files.
- Taps.
- Twist Drills.

SMITH'S TOOLS:

- File Blank Punches.
- File Cutting Chisels.
- Tong Cutters.

STONE CUTTER'S TOOLS:

- Bush Hammers.
- Granite Chisels.
- Granite Points.
- Stone Planers.

WOODWORKING TOOLS:

- Matches.
- Planers.
- Stickers.
- Wood Boring Tools.
- Wood Turning Tools.
- Woodworking Chisels.
- Woodworking Knives.

WEIGHTS OF FLAT ROLLED STEEL

POUNDS PER LINEAL FOOT

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
1/4	.053	.106	.159	.213	.27	.32	.37	.43	.48	.53	.58	.64	.69	.74	.80	.85
1/2	.106	.213	.319	.425	.53	.64	.74	.85	.96	1.06	1.17	1.28	1.38	1.49	1.59	1.70
3/4	.159	.319	.478	.638	.80	.96	1.12	1.28	1.43	1.59	1.75	1.91	2.07	2.23	2.39	2.55
1	.213	.425	.638	.850	1.06	1.28	1.49	1.70	1.91	2.13	2.34	2.55	2.76	2.98	3.19	3.40
1 1/4	.266	.531	.797	1.063	1.33	1.59	1.86	2.13	2.39	2.66	2.92	3.19	3.45	3.72	3.98	4.25
1 1/2	.319	.638	.956	1.275	1.59	1.91	2.23	2.55	2.87	3.19	3.51	3.83	4.14	4.46	4.78	5.10
1 3/4	.372	.744	1.116	1.488	1.86	2.23	2.60	2.98	3.35	3.72	4.09	4.46	4.83	5.21	5.58	5.95
2	.425	.850	1.275	1.700	2.13	2.55	2.98	3.40	3.83	4.25	4.68	5.10	5.53	5.95	6.38	6.80
2 1/4	.478	.956	1.434	1.913	2.39	2.87	3.35	3.83	4.30	4.78	5.26	5.74	6.22	6.69	7.17	7.65
2 1/2	.531	1.063	1.594	2.125	2.66	3.19	3.72	4.25	4.78	5.31	5.84	6.38	6.91	7.44	7.97	8.50
2 3/4	.584	1.169	1.753	2.338	2.92	3.51	4.09	4.68	5.26	5.84	6.43	7.01	7.60	8.18	8.77	9.35
3	.638	1.275	1.913	2.550	3.19	3.83	4.46	5.10	5.74	6.38	7.01	7.65	8.29	8.93	9.56	10.20
3 1/4	.691	1.381	2.072	2.763	3.45	4.14	4.83	5.53	6.22	6.91	7.60	8.29	8.98	9.67	10.36	11.05
3 1/2	.744	1.488	2.231	2.975	3.72	4.46	5.21	5.95	6.69	7.44	8.18	8.93	9.67	10.41	11.16	11.90
3 3/4	.797	1.594	2.391	3.188	3.98	4.78	5.58	6.38	7.17	7.97	8.77	9.56	10.36	11.16	11.95	12.75
4	.850	1.700	2.550	3.400	4.25	5.10	5.95	6.80	7.65	8.50	9.35	10.20	11.05	11.90	12.75	13.60
4 1/4	.903	1.806	2.709	3.613	4.52	5.42	6.32	7.23	8.13	9.03	9.93	10.84	11.74	12.64	13.55	14.45
4 1/2	.956	1.913	2.869	3.825	4.78	5.74	6.69	7.65	8.61	9.56	10.52	11.48	12.43	13.39	14.34	15.30
4 3/4	1.009	2.019	3.028	4.038	5.05	6.06	7.07	8.08	9.08	10.09	11.10	12.11	13.12	14.13	15.14	16.15
5	1.063	2.125	3.188	4.250	5.31	6.38	7.44	8.50	9.56	10.63	11.69	12.75	13.81	14.88	15.94	17.00
5 1/4	1.116	2.231	3.347	4.463	5.58	6.69	7.81	8.93	10.04	11.16	12.27	13.39	14.50	15.62	16.73	17.85
5 1/2	1.169	2.338	3.506	4.675	5.84	7.01	8.18	9.35	10.52	11.69	12.86	14.03	15.19	16.36	17.53	18.70
5 3/4	1.222	2.444	3.666	4.888	6.11	7.33	8.55	9.78	11.00	12.22	13.44	14.66	15.88	17.11	18.33	19.55
6	1.275	2.550	3.825	5.100	6.38	7.65	8.93	10.20	11.48	12.75	14.03	15.30	16.58	17.85	19.13	20.40
6 1/4	1.328	2.656	3.984	5.313	6.64	7.97	9.30	10.63	11.95	13.28	14.61	15.94	17.27	18.59	19.92	21.25
6 1/2	1.381	2.763	4.144	5.525	6.91	8.29	9.67	11.05	12.43	13.81	15.19	16.58	17.96	19.34	20.72	22.10
6 3/4	1.434	2.869	4.303	5.738	7.17	8.61	10.04	11.48	12.91	14.34	15.78	17.21	18.65	20.08	21.52	22.95
7	1.488	2.975	4.463	5.950	7.44	8.93	10.41	11.90	13.39	14.88	16.36	17.85	19.34	20.83	22.31	23.80
7 1/4	1.541	3.081	4.622	6.163	7.70	9.24	10.78	12.33	13.87	15.41	16.95	18.49	20.03	21.57	23.11	24.65
7 1/2	1.594	3.188	4.781	6.375	7.97	9.56	11.16	12.75	14.34	15.94	17.53	19.13	20.72	22.31	23.91	25.50
7 3/4	1.647	3.294	4.941	6.588	8.23	9.88	11.53	13.18	14.82	16.47	18.12	19.76	21.41	23.06	24.70	26.35
8	1.700	3.400	5.100	6.800	8.50	10.20	11.90	13.60	15.30	17.00	18.70	20.40	22.10	23.80	25.50	27.20
8 1/4	1.753	3.506	5.259	7.013	8.77	10.52	12.27	14.03	15.78	17.53	19.28	21.04	22.79	24.54	26.30	28.05
8 1/2	1.806	3.613	5.419	7.225	9.03	10.84	12.64	14.45	16.26	18.06	19.87	21.68	23.48	25.29	27.09	28.90
8 3/4	1.859	3.719	5.578	7.438	9.30	11.16	13.02	14.88	16.73	18.59	20.45	22.31	24.17	26.03	27.89	29.75
9	1.913	3.825	5.738	7.650	9.56	11.48	13.39	15.30	17.21	19.13	21.04	22.95	24.86	26.78	28.69	30.60
9 1/4	1.966	3.931	5.897	7.863	9.83	11.79	13.76	15.73	17.69	19.66	21.62	23.59	25.55	27.52	29.48	31.45
9 1/2	2.019	4.038	6.056	8.075	10.09	12.11	14.13	16.15	18.17	20.19	22.21	24.23	26.24	28.26	30.28	32.30
9 3/4	2.072	4.144	6.216	8.288	10.36	12.43	14.50	16.58	18.65	20.72	22.79	24.86	26.93	29.01	31.08	33.15
10	2.125	4.250	6.375	8.500	10.63	12.75	14.88	17.00	19.13	21.25	23.38	25.50	27.63	29.75	31.88	34.00
10 1/4	2.178	4.356	6.534	8.713	10.89	13.07	15.25	17.43	19.60	21.78	23.96	26.14	28.32	30.49	32.67	34.85
10 1/2	2.231	4.463	6.694	8.925	11.16	13.39	15.62	17.85	20.08	22.31	24.54	26.78	29.01	31.24	33.47	35.70
10 3/4	2.284	4.569	6.853	9.138	11.42	13.71	15.99	18.28	20.56	22.84	25.13	27.41	29.70	31.98	34.27	36.55
11	2.338	4.675	7.013	9.350	11.69	14.03	16.36	18.70	21.04	23.38	25.71	28.05	30.39	32.73	35.06	37.40
11 1/4	2.391	4.781	7.172	9.563	11.95	14.34	16.73	19.13	21.52	23.91	26.30	28.69	31.08	33.47	35.86	38.25
11 1/2	2.444	4.888	7.331	9.775	12.22	14.66	17.11	19.55	21.99	24.44	26.88	29.33	31.77	34.21	36.66	39.10
11 3/4	2.497	4.994	7.491	9.988	12.48	14.98	17.48	19.98	22.47	24.97	27.47	29.96	32.46	34.96	37.45	39.95
12	2.550	5.100	7.650	10.20	12.75	15.30	17.85	20.40	22.95	25.50	28.05	30.60	33.15	35.70	38.25	40.80

WEIGHTS OF SQUARE BARS

Size, Inches	Pounds per Foot	Size, Inches	Pounds per Foot	Size. Inches	Pounds per Foot	Size, Inches	Pounds per Foot	Size, Inches	Pounds per Foot
1/4	.2125								
9/32	.2689	1 1/32	3.616	1 25/32	10.788	2 17/32	21.785	3 9/32	36.606
5/16	.3320	1 1/16	3.838	1 13/16	11.170	2 9/16	22.326	3 5/16	37.307
11/32	.4018	1 3/32	4.067	1 27/32	11.558	2 19/32	22.874	3 11/32	38.014
3/8	.4781	1 1/8	4.303	1 7/8	11.953	2 5/8	23.428	3 3/8	38.728
13/32	.5611	1 5/32	4.546	1 29/32	12.355	2 21/32	23.989	3 13/32	39.449
7/16	.6508	1 3/16	4.795	1 15/16	12.763	2 11/16	24.557	3 7/16	40.176
15/32	.7471	1 7/32	5.050	1 31/32	13.178	2 23/32	25.131	3 15/32	40.910
1/2	.8500	1 1/4	5.313	2	13.600	2 3/4	25.713	3 1/2	41.650
17/32	.9596	1 9/32	5.581	2 1/32	14.028	2 25/32	26.300	3 9/16	43.151
9/16	1.0758	1 5/16	5.857	2 1/16	14.463	2 13/16	26.895	3 5/8	44.678
19/32	1.1986	1 11/32	6.139	2 3/32	14.905	2 27/32	27.496	3 11/16	46.232
5/8	1.3281	1 3/8	6.428	2 1/8	15.353	2 7/8	28.103	3 3/4	47.813
21/32	1.4643	1 13/32	6.724	2 5/32	15.808	2 29/32	28.717	3 13/16	49.420
11/16	1.6070	1 7/16	7.026	2 3/16	16.270	2 15/16	29.338	3 7/8	51.053
23/32	1.7564	1 15/32	7.335	2 7/32	16.738	2 31/32	29.966	3 15/16	52.713
3/4	1.9125	1 1/2	7.650	2 1/4	17.213	3	30.600	4	54.400
25/32	2.0752	1 17/32	7.972	2 9/32	17.694	3 1/32	31.241		
13/16	2.2445	1 9/16	8.301	2 5/16	18.182	3 1/16	31.888		
27/32	2.4205	1 19/32	8.636	2 11/32	18.677	3 3/32	32.542		
7/8	2.6031	1 5/8	8.978	2 3/8	19.178	3 1/8	33.203		
29/32	2.7924	1 21/32	9.327	2 13/32	19.686	3 5/32	33.871		
15/16	2.9883	1 11/16	9.682	2 7/16	20.201	3 3/16	34.545		
31/32	3.1908	1 23/32	10.044	2 15/32	20.722	3 7/32	35.225		
1	3.4000	1 3/4	10.413	2 1/2	21.250	3 1/4	35.913		

WEIGHTS OF ROUND BARS

Size, Inches	Pounds per Foot	Size, Inches	Pounds per Foot	Size, Inches	Pounds per Foot	Size, Inches	Pounds per Foot	Size, Inches	Pounds per Foot
1/4	.1669								
9/32	.2112	1 1/32	2.840	1 25/32	8.473	2 17/32	17.110	3 9/32	28.751
5/16	.2608	1 1/16	3.015	1 13/16	8.773	2 9/16	17.535	3 5/16	29.301
11/32	.3155	1 3/32	3.195	1 27/32	9.078	2 19/32	17.965	3 11/32	29.856
3/8	.3755	1 1/8	3.380	1 7/8	9.388	2 5/8	18.400	3 3/8	30.417
13/32	.4407	1 5/32	3.570	1 29/32	9.704	2 21/32	18.841	3 13/32	30.983
7/16	.5111	1 3/16	3.766	1 15/16	10.024	2 11/16	19.287	3 7/16	31.554
15/32	.5867	1 7/32	3.966	1 31/32	10.350	2 23/32	19.738	3 15/32	32.130
1/2	.6676	1 1/4	4.172	2	10.681	2 3/4	20.195	3 1/2	32.712
17/32	.7536	1 9/32	4.384	2 1/32	11.018	2 25/32	20.656	3 9/16	33.891
9/16	.8449	1 5/16	4.600	2 1/16	11.360	2 13/16	21.123	3 5/8	35.090
19/32	.9414	1 11/32	4.822	2 3/32	11.706	2 27/32	21.595	3 11/16	36.311
5/8	1.0431	1 3/8	5.049	2 1/8	12.058	2 7/8	22.072	3 3/4	37.552
21/32	1.1500	1 13/32	5.281	2 5/32	12.416	2 29/32	22.555	3 13/16	38.814
11/16	1.2622	1 7/16	5.518	2 3/16	12.778	2 15/16	23.042	3 7/8	40.097
23/32	1.3795	1 15/32	5.761	2 7/32	13.146	2 31/32	23.535	3 15/16	41.401
3/4	1.5021	1 1/2	6.008	2 1/4	13.519	3	24.033	4	42.726
25/32	1.6299	1 17/32	6.261	2 9/32	13.897	3 1/32	24.537		
13/16	1.7629	1 9/16	6.519	2 5/16	14.280	3 1/16	25.045		
27/32	1.9011	1 19/32	6.783	2 11/32	14.669	3 3/32	25.559		
7/8	2.0445	1 5/8	7.051	2 3/8	15.060	3 1/8	26.078		
29/32	2.1931	1 21/32	7.325	2 13/32	15.462	3 5/32	26.602		
15/16	2.3470	1 11/16	7.604	2 7/16	15.866	3 3/16	27.131		
31/32	2.5061	1 23/32	7.889	2 15/32	16.275	3 7/32	27.666		
1	2.6704	1 3/4	8.178	2 1/2	16.690	3 1/4	28.206		

WEIGHTS OF HEXAGON BARS

Size, Inches	Pounds per Foot	Size, Inches	Pounds per Foot	Size, Inches	Pounds per Foot
1/4	.1840				
9/32	.2329	1 5/32	3.937	2 9/16	19.335
5/16	.2875	1 3/16	4.152	2 5/8	20.289
11/32	.3479	1 7/32	4.374	2 11/16	21.267
3/8	.4141	1 1/4	4.601	2 3/4	22.268
13/32	.4860	1 9/32	4.834	2 13/16	23.291
7/16	.5636	1 5/16	5.072	2 7/8	24.338
15/32	.6470	1 11/32	5.317	2 15/16	25.408
1/2	.7361	1 3/8	5.567	3	26.500
17/32	.8310	1 13/32	5.823	3 1/16	27.616
9/16	.9316	1 7/16	6.085	3 1/8	28.755
19/32	1.0380	1 15/32	6.352	3 3/16	29.916
5/8	1.1502	1 1/2	6.625	3 1/4	31.101
21/32	1.2681	1 9/16	7.189	3 5/16	32.309
11/16	1.3917	1 5/8	7.775	3 3/8	33.540
23/32	1.5211	1 11/16	8.385	3 7/16	34.793
3/4	1.6563	1 3/4	9.018	3 1/2	36.070
25/32	1.7972	1 13/16	9.673	3 9/16	37.370
13/16	1.9438	1 7/8	10.352	3 5/8	38.692
27/32	2.0962	1 15/16	11.053	3 11/16	40.038
7/8	2.2544	2	11.778	3 3/4	41.407
29/32	2.4183	2 1/16	12.525	3 13/16	42.799
15/16	2.5879	2 1/8	13.296	3 7/8	44.213
31/32	2.7633	2 3/16	14.089	3 15/16	45.651
1	2.9445	2 1/4	14.907	4	47.112
1 1/32	3.131	2 5/16	15.746		
1 1/16	3.324	2 3/8	16.609		
1 3/32	3.522	2 7/16	17.494		
1 1/8	3.727	2 1/2	18.403		

WEIGHTS OF OCTAGON BARS

Size, Inches	Pounds per Foot	Size, Inches	Pounds Per Foot	Size, Inches	Pounds per Foot
1/4	0.1760				
9/32	0.2228	29/32	2.3133	1 17/32	6.604
5/16	0.2751	15/16	2.4756	1 9/16	6.877
11/32	0.3328	31/32	2.6434	1 19/32	7.154
3/8	0.3961	1	2.8167	1 5/8	7.438
13/32	0.4649	1 1/32	2.995	1 21/32	7.727
7/16	0.5391	1 1/16	3.180	1 11/16	8.021
15/32	0.6189	1 3/32	3.370	1 23/32	8.321
1/2	0.7042	1 1/8	3.565	1 3/4	8.626
17/32	0.7949	1 5/32	3.766	1 25/32	8.937
9/16	0.8912	1 3/16	3.972	1 13/16	9.253
19/32	0.9930	1 7/32	4.184	1 27/32	9.575
5/8	1.1003	1 1/4	4.401	1 7/8	9.902
21/32	1.2130	1 9/32	4.624	1 29/32	10.235
11/16	1.3313	1 5/16	4.852	1 15/16	10.573
23/32	1.4551	1 11/32	5.086	1 31/32	10.917
3/4	1.5844	1 3/8	5.325	2	11.267
25/32	1.7191	1 13/32	5.570		
13/16	1.8594	1 7/16	5.820		
27/32	2.0052	1 15/32	6.076		
7/8	2.1565	1 1/2	6.337		

Size of Hexagon and Octagon Bars is the dia. of inscribed circle or distance between opposite faces.

CARBON TOOL STEEL

Extras as recommended by the Committee on Steel and Steel Products of the American Iron & Steel Institute, January 7, 1918.

Base Sizes—Rounds, Squares and Octagons, 5/8" to 2", inclusive; Flats, 9/16" to 2" thick, by 5/8" to 2" wide.

EXTRA SIZES

Rounds, Squares and Octagons

Size, Inches	Extra, Cents per Lb.	Size, Inches	Extra, Cents per Lb.
1/8	18.0	5/8 to 2	0.0
5/32	10.0	7 1/8 to 8	3.5
3/16	5.0	6 1/8 to 7	3.0
1/4 to 9/32	3.0	5 1/8 to 6	2.5
5/16 to 11/32	2.0	4 1/8 to 5	2.0
7/16 to 3/8	1.0	3 1/8 to 4	1.5
9/16 to 1/2	0.5	2 1/8 to 3	1.0

Flats

Size, Inches	Extra, Cents per Lb.	Size, Inches	Extra, Cents per Lb.
1/8 x 3/16	20.0	5/16 x 3/8 to 5/8	1.5
1/8 x 1/4	15.0	5/16 x 11/16 to 8	1.0
1/8 x 5/16	8.0	3/8 x 7/16 to 8	1.0
1/8 x 3/8	4.0	7/16 x 1/2 to 8	1.0
1/8 x 7/16 to 1/2	3.0	1/2 x 9/16 to 8	1.0
1/8 x 9/16 to 7	2.0	7/16 x 2 1/8 to 8	1.0
1/8 x 7 1/8 to 8	3.0	9/16 to 2 x 5/8 to 2	0.0
3/16 x 1/4	5.0	5/8 to 2 x 2 1/8 to 7	1.0
3/16 x 5/16	4.0	5/8 to 1 3/4 x 7 1/8 to 8	1.0
3/16 x 3/8	3.0	1 7/8 to 2 x 7 1/8 to 8	1.5
3/16 x 7/16 to 5/8	2.0	2 1/8 to 3 x 2 1/8 to 5	1.0
3/16 x 11/16 to 2	1.5	2 1/8 to 3 x 5 1/8 to 8	1.5
3/16 x 2 1/8 to 7	1.0	3 1/8 to 4 x 3 1/8 to 6	1.5
3/16 x 7 1/8 to 8	2.0	3 1/8 to 4 x 6 1/8 to 8	2.0
1/4 x 5/16 to 3/8	2.0	4 1/8 to 5 x 4 1/8 to 7	2.0
1/4 x 7/16 to 5/8	1.5	4 1/8 to 5 x 7 1/8 to 8	2.5
1/4 x 11/16 to 2	1.5	5 1/8 to 6 x 5 1/8 to 8	2.5
1/4 x 2 1/8 to 7	1.0	6 1/8 to 7 x 6 1/8 to 7	3.0
1/4 x 7 1/8 to 8	2.0	6 1/8 to 8 x 7 1/8 to 8	3.8

All dimensions of sizes are inclusive.
Intermediate sizes take the next higher extras.

CUTTING TO SPECIFIED SINGLE AND MULTIPLE LENGTHS

Length, Inches	Extra, Cents per Lb.
6 to 12 inches	2.0
12 to 18 inches	1.5
18 to 24 inches	1.0
24 inches or over	0.5

Less than 6 inches, special price.
Over 18 feet, special price.

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